The CORNELL ENGINEER

IN THIS ISSUE

•

MAGNETIC RECORDING OF SOUND
by
S. R. Irish, ME '41

•

MANAGEMENT LOOKS TO THE FUTURE
Part II
by
Prof. J. R. Bangs

•

MODERN PLASTICS
by
H. E. Otto, AE '42

•

•

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me 5 Number 2

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CONTENTS

OUR AUTHORS

This month two of the members of the editorial board of The Cornell Engineer, S. R. Irish, M.E. '41 and H. E. Otto, A.E., M.E. '42 inform us on Magnetic Recording of Sound and Modern Plastics, respectively. Irish, always having been interested in sound recording, explains a new medium with applications in fields beyond the scope of present devices. Otto received his inspirations this summer while visiting plastc exhibits at the World's Fair in New York, and passes his interts on to us.

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OUR COVER

A photograph of the new model of the proposed engineering college, on exhibit in Sibley Dome.

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A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.

Vol. LIII.—No. 16. [NEW SERIES.] NEW YORK, OCTOBER 17, 1885. [$3.20 per Annum. [POSTAGE PREPAID.]

1. Sibley College Museum of Mechanism. 2. General View, showing a Portion of the University Buildings and Grounds, Sibley College Buildings in the Distance. 3. The Sibley College Forge Shop. 4. The Sibley College Buildings, Dr. R. H. Thurston, Director. 5. The Sibley College Foundry. 6. Fall Creek Reservoir and Water Supply. 7. The Sibley College Draughting Room. 8. The Sibley College Machine Shop.

ILLUSTRATIONS OF SIBLEY COLLEGE, CORNELL UNIVERSITY, ITHACA, N. Y.—[See page 247.]

SIBLEY COLLEGE IN DR. THURSTON'S TIME

From an old cover of the *Scientific American*

Magnetic Recording Of Sound

By S. RUSSELL IRISH, JR., M.E. '41

Much has been written in the last few years concerning the progress and advancement in the recording of sound by the conventional phonograph disk method and by the photographic method of producing a sound track on moving film, as used in the motion picture industry. However, until very recently little consideration has been given in this country to the magnetic system of recording on steel wire and tape. Most of the development of this type of recording has been done in Europe—particularly in Germany and England. There has been such progress that magnetic reproduction, in many applications, is superior to either disk or film recording.

In this system the variations in sound are recorded as variations of magnetism along a steel wire or tape. To record the sound, a steel tape or wire is drawn past an electromagnet which is energized by a fluctuating current corresponding to the variations in sound, thus leaving similar variations in magnetism on the wire. To reproduce the sound, the tape is drawn past another coil in which it induces a varying electromotive force corresponding to the variations in magnetism. The current thus set up may then be amplified and used.

This magnetic system or recording has several advantages not found in the other types of recording. Since the recording involves only changes in the magnetic properties of the record material it may be re-used a number of times. The tape or wire can be wound on reels in quite long lengths permitting continuous recordings of long duration without breaks or interruptions. In addition, the record may be replayed hundreds of times without appreciable loss in quality. The fact that both recording and reproducing are unaffected by vibration and mechanical shock make the magnetic recorder the ideal portable outfit.

On the other hand, there are some drawbacks and disadvantages to this system. Rather high tape speeds are necessary for extended fidelity making the tape or wire excessively long and greatly increasing the wear on the pole pieces of the recording and reproducing magnets. There is a tendency to produce high back ground noise due to variations in structure of the tape and to vibration of the tape as it passes the pole pieces. Also the record itself is rather large and difficult to store if the recording is of any permanent value.

Although the development of this type of recording has been recent, the original idea was conceived nearly 40 years ago by a Danish physicist named Poulsen. Just at the turn of the century when the wireless was first demonstrating its possibilities, Poulsen developed the "telegraphone" to be used in conjunction with his arc system of radio-telegraphy. Messages were sent at very high speed, and at the receiving station were recorded magnetically on steel wire. Later the message was replayed with a lower speed at which the operator could conveniently read.

By 1903 there had been developed several different types of telegraphones for the reproduction of speech and music. One machine, designed to resemble the gramaphone, used a steel disc as the recording medium. Another used a steel tape wound helically on a cylinder, over which the recording magnet rode, much in the manner of the old wax dictaphone records. A third type, using a steel wire as the medium, was described in the *Scientific American* Magazine in 1903:

> "In clearness of reproduction, this wire instrument leaves nothing to be desired. The articulation could not be improved."

However, magnetic recording did not progress, and was forgotten for some twenty years, until 1924 when a German engineer, Dr. Stille, started research in this field. He studied both the electro-magnetic and mechanical problems and made several notable advances. He introduced the use of steel tape in place of wire and developed an electro-magnetic system which reduced wave form distortion.

In England research started about 1930 when the British Broadcasting Corporation began investigating a recorder called the Blattner-phone. From this was developed a machine which is now used to record programs for subsequent rebroadcasts on short wave bands. The first program that the British re-broadcast from a magnetic recording was the New Year's Day address of the late King George V in 1932.

American research on magnetic recording has been

confined to recent years. In April 1937 the Bell Telephone Laboratories published results of their experiments, describing a method of producing the magnetism slightly different from the methods used abroad. Both the American and European systems will be described in more detail in the following pages.

With any method of recording on steel wire or tape there are four essential parts to the apparatus: First, there must be a polarizing or wiping magnet which magnetically saturates the wire or tape thus erasing any previously recorded signals. Second, there must be a recording head consisting of a pole-piece which makes contact with the recording medium and which is surrounded by a coil carrying the signal current. The fluctuations in current passing through these coils produce variations of remanent flux in the tape or wire as it passes the pole piece. Third, there must be a reproducing head similar in construction to the recording head. The variations of flux in the tape or wire passing this head induce a varying electromotive force in its coils. The currents thus set up correspond to the signal current used to produce the record. The fourth essential is a constant speed drive for the tape or wire both in recording and reproduction. This is an obvious necessity, since changes in tape speed would alter the pitch of the sound.

Two different methods of magnetization are employed in recording on steel tape or wire. One, called longitudinal magnetization, produces magnetic forces parallel to the length of the tape. The other, in which the magnetic forces are parallel to the thickness of the tape, is called perpendicular magnetization. Most of the work done abroad has been with the longitudinal method. However, the Bell Laboratories experiments have been with perpendicular magnetization.

Two methods of longitudinal magnetization are being used—one and two pole-piece recording. Brief consideration will be given to both methods. Figure 1 illustrates the changes taking place in recording with one pole-piece. M is the recording medium and P the recording pole-piece. The medium has been previously saturated by drawing it past a polarizing magnet so that the residual magnetism is in the direction indicated by the upper arrow on the left. The magnetization is practically parallel to the length of the tape but for simplicity has been pictured at a considerable angle. If the pole-piece P carries a steady flux as indicated by the heavy lines, the flux will spread through the medium. As an elementary length of tape approaches position 1, it is subjected to a flux substantially in the same direction as the residual magnetism, therefore having no appreciable effect. At position 2 it is acted on by a flux perpendicular to the residual flux, and at position 3 by a flux in opposition to the original magnetization. Thus the flux at point 3, if modulated, would leave a signal record on the medium which would be undistorted if it were not for the changes in direction of flux while the elements were passing from position 1 to 3. The spreading of the flux at 3 covers an appreciable distance so that the tape must travel at high speed to keep the recorded signals from being distorted by subsequent signals. Figure 2 shows two pole-piece recording in a similar manner. If the two pole-pieces are kept fairly close together there will not be much spreading of flux. The flux at position 1 will have little effect, being in the same direction as the remanent flux, while the flux at position 2 is in the opposite direction and if modulated would leave an undistorted record were it not for the changes in direction of flux in passing from position 1 to 3. However, the elements must still pass pole-piece 2 where they are subjected to flux at 4 and 5 which distort the signal recorded at 3. Thus the distortion is much greater than for one pole-piece recording. In practice fluxes at 4 and 5 can be kept sufficiently small so that the additional distortion can be accepted in exchange for the improved frequency response afforded by the two pole-piece method.

The experiments of the Bell Laboratories have been concerned with a method of magnetization different from either of two longitudinal systems. In their method the pole pieces are directly opposite each other, with the thin dimension of the tape between them. The flux path is thus made very short, so that there is very little spreading of flux, and the width of the flux path is not dependent on signal strength. This reduction in flux spread permits the tape speeds to be reduced considerably.

In this system the magnetization

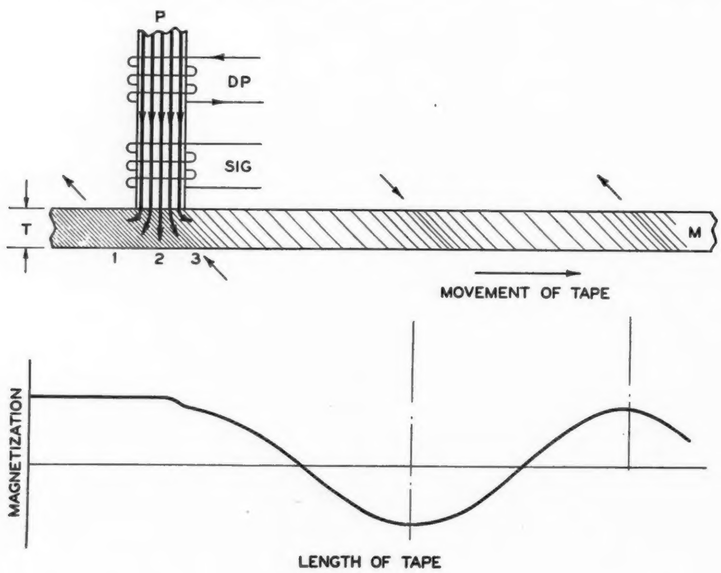


Fig. 1

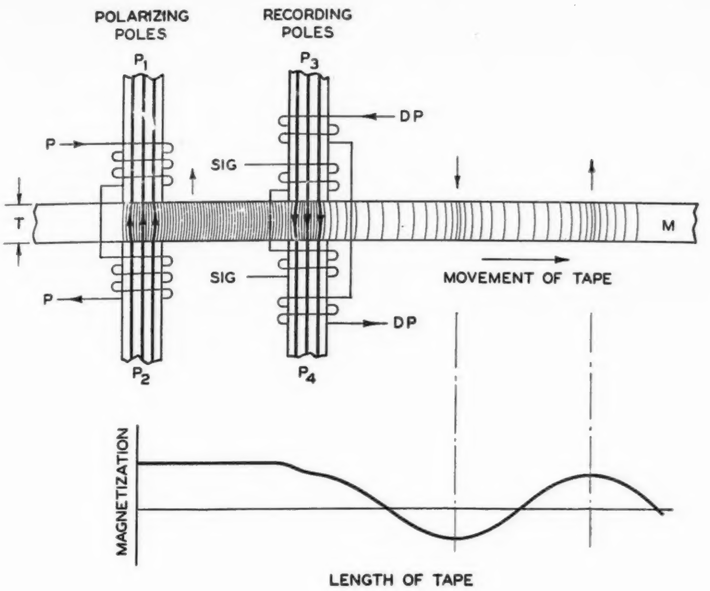


Fig. 2

is produced parallel to the thickness of the tape, with a direction as shown by the upper arrow on the left in the figure 3. As the elementary lengths of tape enter the polarizing field, they are magnetized to the saturation point P in the figure 4. As they leave this field, magnetization drops to the point R when the applied field is zero. Entering the recording field, which carries a steady flux opposed to the polarizing field, the induction is reduced to point N. However, if there is a signal current super-imposed on the biasing current, the magnetization will be reduced either to point A or point B, depending whether the signal flux aids or oposes the bias flux. Upon leaving the pole-pieces, the field drops to zero and the residual magnetism changes to points A' or B'.

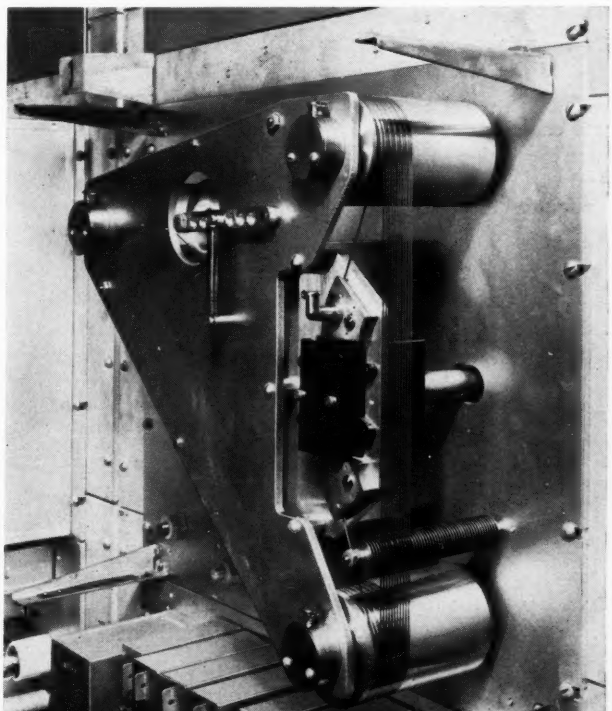
Brief consideration will now be given to the various types of equipment being used in magnetic recording. The British Broadcasting Corporation's broadcast recorder is a good example of a machine developed for recording with the longitudinal two-pole-piece method.

First, the construction of the polarizing or wiping head, the recording head, and the reproducing head will be discussed. Each head consists of two similar blocks of insulating material hinged together at the back. When these blocks are close, a slot is formed through which the tape passes. In each half there is provision for placing a strip of magnetic material known as the pole-piece which contacts the tape at right angles to its surface. These pole-pieces are surrounded by coils through which they are free to slide. The pressure of the pole-pieces is adjusted by spring-loaded plungers. These coils surrounding the pole-pieces carry the erasing and recording currents when used for polarization and recording. In reproducing, the coils are the seats of the electro-motive forces induced by the variations in magnetism recorded on the passing tape. Wiping, recording, and reproducing heads are of the same construction, except in the type of coil and pole-piece used.

The pole-pieces used in the British machine are made from alloy steels, Stalloy being used in recording, while Permalloy is employed in the reproducing poles. They are 3 mm. wide, 19 mm. long and 0.37 mm. thick, with the tips reduced to 2 mm. wide and 0.06 mm. thick. The tips are heat-treated after shaping.

The manufacture of the tapes used in the machines is carried on especially carefully, since the reduction of background noise depends largely on uniformity of structure and surface of the tapes. They are made from the highest grade of tungsten magnet steel, undergoing numerous heat treatments to reduce the magnetic aging to a minimum. The tape, in its finished form is 0.08 mm. thick and

(*Continued on page* 26)



The United States weather forecast is recorded on this continuous magnetic tape and is repeated to more than 70,000 people each day.

Management Looks to The Future

PART II

By PROFESSOR JOHN ROBERT BANGS ME, '21

Product Design As A Constructive Force In Marketing

A very marked trend developing particularly during the depression years is toward a constant study of the product. Such studies reveal the fact that appearance is a dominant factor. Not many years ago appearance was merely a matter of covering the product with the greatest possible amount of ornamentation.

Today all that is changed. Artists and engineers are combining their efforts not only to give the public a better looking product but also one that is basically lower in cost and more useful.

This movement has given rise to the comparatively new profession of Industrial design which, briefly stated, is "the art of giving a *properly engineered product* of striking, pleasing appearance."

The trend toward the future seems to be in the direction of recognizing the beauties of machine production. Our machines cannot give us the subtle quality of variation that characterized the work of the old artist artizan. They can, however, give us the beauty of precision—the exactly straight line, the perfect circle, the precise arc—qualities which the old craftsman sought after but never attained.

Advertising, An Integral Part of Marketing

"Not advertising," says the wit, "is like kissing a pretty girl in the dark—you know what you are doing but nobody else does." But the mere *act* of advertising thus implied is not enough. Says Advertising Research Director Frank Contant: "It is not the *act* of advertising that makes firms successful; sound advertising is a combination of art and *scientific fact finding.*"

There are indications that "radio's amazing stepchild"—television—once it becomes commercially acceptable, may prove to be the answer to the advertising man's dream. The possibilities of telecasts from places of business direct to the home of the consumer are latent with future possibilities.

All along the line, management is examining advertising with critical eyes, and there are, as a result, indications that the future will see a type of advertising which rests securely upon the foundation of solid fact about the identity, habits, and opinions of their present and prospective customers, *Kept up-to-date by constant research.*

Extension of Scientific Methods

The application of scientific methods is continuing to make progress in marketing. In addition to the growth of statistical techniques, other factual approaches tested for decades in the factory, are being applied in marketing. For example, salesmen are today routed scientifically over their territories in very much the same way that parts to be manufactured are routed through a factory. The time of the salesman is thus carefully studied and controlled, and his efforts coordinated with the home office.

The old production center method of keep costs now finds its counterparts in the sales zone where modern cost methods are finding wide application. In fact, the use of standard costs, with variations from the standard used as means of control, is finding an even more fruitful application in Sales zones than in production centers. And the use of such variations from standards or "variances" as they are called, is nothing more or less than management by "the law of exceptions" first recognized by Frederick W. Taylor at the turn of the century.

Personal

Seeing The Problem As A Whole

When Andrew Carnegie was asked the question: Which is most important, labor, capital, or brains? the canny old Scotchman countered with the question: "Which is the most important leg of a three legged stool?"

This viewpoint of seeing the problem as a whole is receiving increasing emphasis in management today.

And rightfully so. Labor, management, and the public are not separate entities but parts of a living whole.

In personnel management, this attitude is expressed by considering "the job + the worker + the supervisor"—in other words, the total work situation. This broader concept of the work problem makes the foreman industry's leading personnel man. His job combines the functions of a craftsman, a teacher, a salesman (to sell company policies and ideas), and a business man. Hence, training in foremanship, both within and without the factory, is a most noticeable trend in personnel management today.

Labor Relations

Apropos of the trend toward collective cooperation, the personnel of an industrial enterprise has been defined as "a social organization composed of various groups." In the process of dealing with these groups, management has seen the rise of governmental agencies and supervision: the Wagner Act, the National Labor Relations Board, and other forms of control and restraint.

It seems desirable on the part of both management and labor that this trend towards greater government control be checked. Should it continue, we may reach the point where collective bargaining by management and workers would not be between themselves, but with Congress and with the Federal Administrative Agencies. Thus centralizied government control of labor relations may spell the doom of labor unionism by leaving it with little or no function to perform.

Wage Administration and Incentives

The trends in this area are indicated by the great activities in the field of occupational characteristics and rating; job evaluation, wage and salary surveys, key man bonuses, profit sharing, etc.

There are indications that differentials in rates of pay are not always the strongest drives motivating the worker. They are very important, however, for symbolizing individual and group recognition. A carefully worked out job-grading plan which has fair base rates and is fully accepted by the workers is often more important, however, for symbolizing individual and group recognition. A carefully worked out job-grading plan which has fair base rates and is fully accepted by the workers is often more important than large differentials in pay.

The trend in profit sharing is in the direction of increasing the effectiveness of executives. It does not seem to be equally effective for manual and clerical workers.

Unemployment and Social Security

The problems of management in the field of social security now seem to relate themselves to the adjustment of private plans of Federal and state laws. It is generally conceded that old age annuities under the Social Security Act will be inadequate except for those employees whose pay ranges in the lower income brackets.

Motion Study at Cornell

Progressive management has long viewed retirement or pension plans as good business and many companies had workable schemes long before the date of the present social security legislation. Since the passage of the law, many of these plans have been changed and some companies are adopting plans which will supplement those of the government.

On the other hand, private unemployment plans seem to be on the decrease. The scale of dismissal allowances for employees laid off because of slack times will probably be cut because of state unemployment insurance plans, although there is no present indication that they will be abandoned.

These intimate connections between private plans for social security and government plans is an illustration of the trend of the times which points to the need for the fullest cooperation between business and government.

Industrial Psychology

For a number of reasons principally arising from lack of understanding and cooperation, industrial psychology has made comparatively meagre progress in the United States. It is estimated that there are not more than 25 plants in the United States employing full time psychologists; although a considerably greater number employ them on a part time or consulting basis.

Selection and vocational guidance is receiving widespread attention in Germany and Italy and is gaining continued support in France. The German and Italian approach emphasizes the development of skills as a means for overcoming unemployment.

The National Institute of Industrial Psychology in Great Britain is perhaps the leader in the field today. Outstanding work is being done in testing techniques of all character, and many valuable studies pertaining to staff grievances; accident prevention and causes of maladjustment between executives, etc. are being made available.

In spite of its lack of whole-hearted acceptance of industrial psychology, able American management has, nevertheless, built a new concept of the worker in his relation to the machine. Briefly stated, this concept reads: "that the machine is a tool in the hands of a worker, an extension of his fingers and hands, a device enabling him to produce better goods at lower cost." Since the worker is the controllable factor in this production combination, it will be but a matter of time before top management will apply all of the scientific techniques available.

To this end, workers in the field are seeking to obtain not only approval and interest, but also participation on the part of the top executives. That a trend towards such participation is discernable gives promise for the future.

Administration

An English business man, while visiting Africa, went on a lion hunt with a seasoned sportsman. When lion tracks were discovered, the timid merchant said:

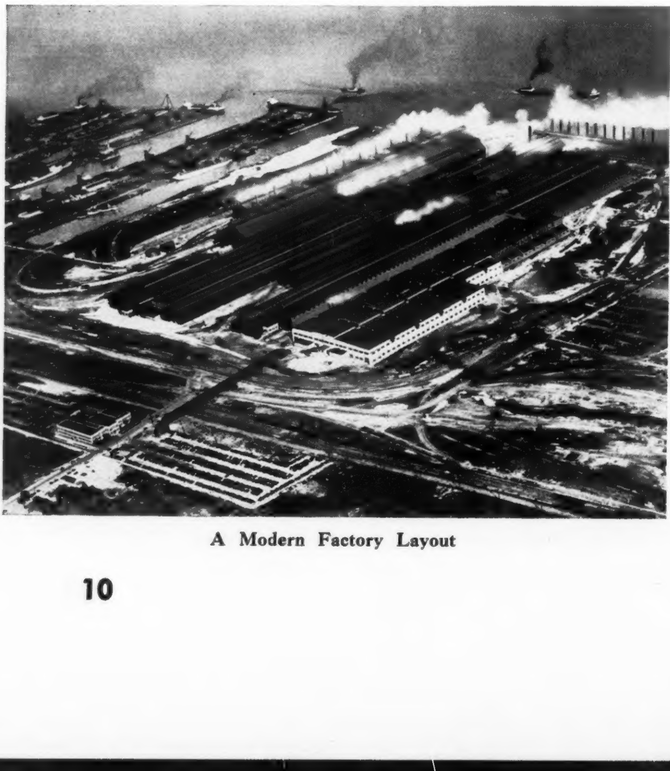
"You go ahead and see where he went and I'll go and see where he came from."

This point of view unfortunately may exist in administration. We find it easy to consider facts in a historical setting; on the other hand, we may find it extremely difficult to plan ahead intelligently and to forecast future developments.

The fact remains, however, the progressive top management is going after the lion. And this constitutes one of the outstanding indications of management in the world of tomorrow.

Organization

"*Organization,*" says President Walter D. Fuller of the Curtis Publishing Company, "is the human machine by which we work together, and *Administration* is the direction of that machine."



A Modern Factory Layout

In organization, the line and staff principle predominates. There is a slight trend at present to provide, as in the modern military organization, a chief of staff placed between the chief executive and the staff officers

The chief of staff tends to save the time of the major executive by reducing the number of persons reporting to him. He further is able to coordinate the work of the various specialists and sum up their conclusions, since he may view the results of their efforts upon the *organization as a whole.*

The future points towards an organization in which the chief executive would have directly under him the major division of production, marketing, finance, accounting, personnel, etc., while his chief of staff essentially an analyst and organizer (not an executive) would have authority over the divisions of planning, research (not technical), and other specialized functions which are of immediate and constant value to the executive.

Public Relations

Business as a general thing has not done a good job of selling itself to the public. But it is improving and we may look forward to relationships being carried on on a much higher plane in the future.

Says President Howard Coonley of the National Association of Manufacturers, "Management has become more 'social minded' and the public has become more 'business minded'. Together they are working to adjust themselves to changes that can be made on a practical basis. And as they move closer together, they tend to enforce upon officialdom a more moderate point of view."

Good public relations are now known to be essential to the success of the individual enterprise and to industry as a whole. They are, in a sense, like a "two way street" which enables a firm to make clear its policies to the public, and in turn, learn from them their attitudes and desires.

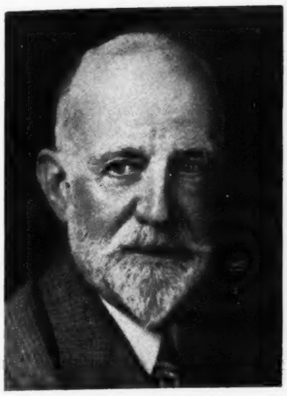
Top management, concerned as it has always been with forces within the business, is shifting its sights to include a broader picture of the external forces. The public, on the other hand, is receiving intelligent information of the great advances constantly being made, and when one realizes that during the five worst years of the depression there were more advances in metallurgy, chemistry, and design than in any previous thirty years, he is bound to increase his respect for management and the profit system.

Training The Administrator of Tomorrow

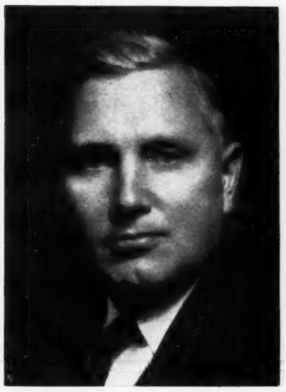
At the Seventh International Management Congress, Dr. Elton Mayo of the Harvard Graduate School of Business said, "We are moving in a world which, at the moment, is in grave need of able administrators at all levels, of all ages—and this same world is doing little or nothing to find such men and to train them."

(*Continued on page* 25)

THURSTON CENTENNIAL


DR. DURAND


ADMIRAL BROWN


DR. ADAMS


DR. DAVIS

By ROBERT G. IRISH AE, '40

In the fall of 1868, Cornell University opened its doors, and, coincident with the ideas of Ezra Cornell, there was, among other courses, a department of Mechanic Arts. This was not, however, in the true use of the word, an engineering school. Civil engineering was taught from the very beginning, but mechanical engineering as it is known today did not exist.

In the late 1870's, the engineering world became aware of a young man teaching at Stevens Institute of Technology. He had graduated from Brown University, served in the Navy during the Civil War, and had taught at the Naval Academy at Annapolis before going to Stevens. This young man, Dr. Robert Henry Thurston, had established the first college experimental engineering laboratory in the country and had written the first text on the subject. Dr. Andrew D. White, the University's first president, had been conferring with Dr. Thurston on numerous occasions regarding Cornell's young engineering school. One day as Dr. White was leaving Thurston's house after one of his rather frequent visits, he thought as he went down the walk, "Why am I asking this man for advice when he is the man I need." So Dr. White turned around, went back to Dr. Thurston's front door and said, "Dr. Thurston, will you come to Cornell?" Thurston answered in the affirmative, thus starting Cornell on its way to becoming the leading engineering school of its time.

Thurston established a laboratory as he had at Stevens, changed teaching methods, and introduced new subjects. To do this he gathered about him the best men in the country, and in a relatively short time Cornell had become the most advanced and well known engineering school in the world. The period that followed might well be called the 'hey-day' of engineering at Cornell. Cornell's plant, her buildings and equipment were superior to any in the country. Men who studied under Thurston went all over the country to teach in other schools, and went into industry to become the heads of many of the outstanding corporations of today. Dr. Thurston established a tradition; engineering as it is known today was originated by Thurston.

On the occasion of the hundredth anniversary of Thurston's birth on October 25th, a celebration was held at which the attendance of noted engineers, alumni, faculty, and students, attested for his greatness. The main feature of the centennial was the convocation held in Bailey Hall. Speakers included Dr. William F. Durand, professor of marine engineering at Cornell from 1891 to 1904, emeritus professor of mechanical engineering at Leland Stanford, past president of the A.S.M.E. and Dr. Thurston's biographer; Dr. James P. Adams, vice-president of Brown University, where Dr. Thurston was an undergraduate; Admiral Wilson Brown, superintendent of the U. S. Naval Academy, where Thurston taught after his active service in the Navy during the Civil War; Dr. Harvey N. Davis, past president of the A.S.M.E. and president of Stevens Institute of Technology, where Thurston established the first mechanical engineering laboratory; and Dean S. C. Hollister of Cornell, where Thurston during his eighteen years of service established the most comprehensive engineering laboratories.

Representatives were present from many engineering colleges, universities, and engineering schools, as were the representatives of societies of which Thurston was a member.

Besides the convocation, there was an exhibit of apparatus which Thurston invented for his mechanical engineering laboratories, and a display of his numerous articles and books.

Modern Plastics

By HENRY E. OTTO '42, A.E.

During recent years the attention of the engineer has frequently been focused upon the startling developments in the "plastics" industry and the versatile applications of these newly created materials to current engineering problems.

History

Although the first phenolic resin—a leading plastics base—was not produced until 1907, it is interesting to learn that as early as 1855 a substance known as Patent Parkesine was molded by Alexander Parkes. In the next decade he molded combs, medallions, camera plates, handles, and plaques. Parkesine was highly inflammable as it was made of nitro-cellulose and camphor.

The phenol resinoid plastics invented by Dr. Baekland in 1907 possessed certain properties that made them immediately beneficial to the industrial world. Since that date chemical research has developed more than 2,000 distinctive substances. Some of these readily familiar to everyone are the steering wheel of the automobile, binoculars, imitation jewelry, and electric shavers. Among their more technical uses they serve in low-loss radio insulators, refrigerators, and ply bonded airplane wings and fuselages.

Constituents and Their Sources

A wide range of raw materials is used in the manufacture of various plastics. For instance, one prominent manufacturer uses cellulose acetate as a base, for it is economical, strong, and easily molded. This product may be remolded; that is, repeatedly softened and hardened by heating and chilling. No chemical change occurs during the molding operation. While imperfect articles and the sprue, or flash—excess of material which flows into crevices in order to insure a full mold—may be reused, it is obvious that for articles which must withstand heat this base would be impractical.

Another manufacturer uses phenolic resinoid as the basic ingredient, which is responsible for the rapid hardening in that heat which first renders the molding material plastic and thereafter chemically changes them. Once molded and cooled, this product cannot be returned to a fusible state at any temperature or pressure. Such special properties as increased strength and durability or improved molding qualities are controlled by the filling agents among which are cellulose, asbestos, fabric, and paper. Mineral fillers increase the degree of heat and water resistance.

Most plastics are pressure molded; however, such articles as pipe stems, parasol handles, and bracelets are roughly cast to the desired shape, then machined and finished.

Two general methods are employed for molding thermoplastic compounds—compression molding and injection molding. The former was used with earlier molding compounds a long time before modern plastics were produced. Injection molding is a recently developed method which, because of its economy and speed, is rapidly gaining prominence.

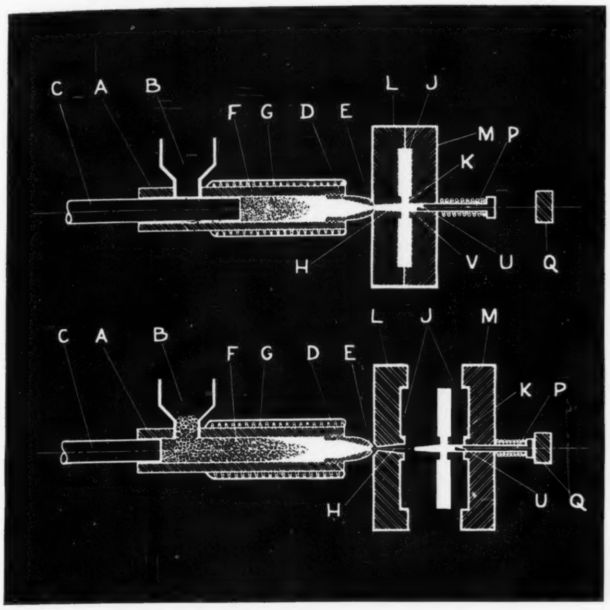
Injection Molding

Equipment for injection molding is illustrated diagrammatically below. The upper drawing shows the equipment in closed position at the end of the injection stroke, and the lower drawing shows it in open position during the ejection of the molded piece.

"A" is the heating cylinder, fitted at "B" with a hopper or other feed device for the introduction of molding powder. Into one end of the heating cylinder is fitted a piston or ram "C" driven mechanically, or by hydraulic or pneumatic pressure. The other end of the cylinder terminates in a constriction "D" leading to an orifice "E". The molding powder "F" in the heating cylinder is compacted by the piston and is heated. For this purpose the drawing shows an electrical resistance unit wound around the outside of the cylinder, at "G." The molding powder thus is brought to a condition of plasticity or fluidity, so that pressure of the piston may force some of it out of the heating cylinder through the orifice "F."

During the injection stroke, the orifice "E" communicates directly with the gate "H" leading to the mold cavity or cavities. In the drawing, two cavities "J" are shown. These cavities, together with the gate "H" are formed by the two halves of the mold "L" and "M," which are held together by a locking device, which prevents their being forced apart by the pressure transmitted from the piston through the semi-liquid material.

Immediately upon entering the mold cavity, the molding compound begins to cool and resume its nor-



Courtesy of DuPont

mal rigidity. As soon as the article is rigid enough to be removed from the mold without distortion, the pressure upon the piston is released, the locking device is opened, and the mold is pulled away from contact with the injection orifice, as indicated in the lower sketch. This causes a breaking of the thin ribbon of solidified material in the gate at its point of minimum cross-section, which is normally located just inside the orifice opening at "E." The opening of the mold by movement of the mold half "M" to the right brings the end of a knock-out pin "P" into contact with a stop "Q" and thus causes the pin to push the molded product, i.e., the two articles and their sprues, out of the mold.

Removal of the sprue and the rubbing off of any slight overflow along the parting line normally leaves the molded article in a finished condition ready for shipment.

It is very important to provide positive means of emptying the gates and their branches, or runners, after each cycle, so as to leave them clear for the introduction of the next charge. A proper constriction at the orifice of the heating cylinder, as indicated at "E" in the figure, will ordinarily ensure the breaking of the sprue at that point. As a further precaution, it is frequently wise to provide what is known as a necked or hooked head (i. e., a cavity with a slight undercut) continuous with the gate, as shown at "U" in the figure. The gripping action of the slight undercut at this point holds the molded article in the movable half of the mold, "M," and ensures that the sprue breaks at "E" so as to clear the gate "H" for the next stroke.

When the mold has been separated from the orifice end of the heating cylinder for the removal of the molded articles, there is a possibility that the softened material within the orifice may become somewhat chilled and hardened, and this plug of insufficiently soft material may cause trouble on the next stroke, either by obstructing the flow through the gates or the runners, or, if it is driven through into one of the mold cavities, by creating a local imperfection in the molded article. To avoid these difficulties, particularly when several cavities are served by comparatively narrow branch gates or runners, it is desirable to provide a recess or vent which will trap this comparatively hard material and allow the softened material behind it to flow properly into the cavities. Such a vent is shown at "V" in the figures. In the construction shown, the vent "V" and the undercut or hooked head "U" are combined into a single part.

The temperature to which the molding powder should be heated in the heating cylinder depends upon the composition of the molding powder, the type of article being made, and the size of the molds, but will ordinarily range between about 300° F. and 420° F. Insufficient heating prevents the material from flowing properly through the orifice into the mold, and the articles formed are incomplete. Excessive temperature is undesirable, chiefly because it emphasizes the shrinkage of the article during its cooling in the molds and may thus result in the defect known as "shrink marks," i. e., local depressions in the surface of the molded articles. It is important that the proper temperature be established and maintained.

The temperature of the heating element itself, which may be read by means of a pyrometer, will ordinarily be considerably higher than the temperature of the molding material within the cylinder. A voltmeter across the terminals of the heating unit is helpful in controlling the heating. The heating, however, can be controlled thermostatically.

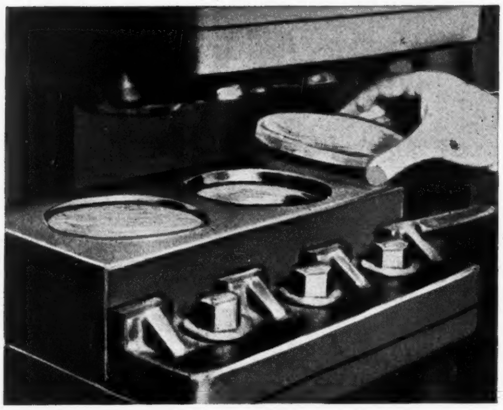
The mold is always maintained at a temperature below that at which the molding material is soft or plastic. Thus each charge of material entering the mold becomes set to a rigid condition. In some cases the natural heat losses from the body of metal constituting the mold and its retaining members suffice to dissipate the heat as fast as it is introduced by successive charges of hot material, and it is then not necessary to provide positive means of abstracting heat. In other cases, however, the mold must be cored for cooling or else attached to a cored cooling plate. Usually the mold temperature is between 80° F. and 150° F.

Successful operation of injection molding equipment requires a proper balance between temperatures, pressure, and the duration of the cycle, and the best conditions, once ascertained, must be carefully maintained.

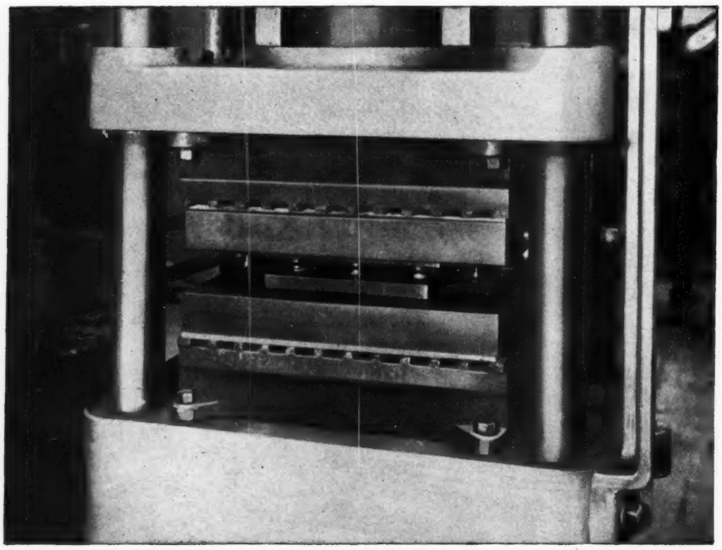
In designing molds and the holders and locking devices which may be associated with them, it is imperative to recognize the magnitude of the force tending to open the mold when the cavity is full of semi-

(*Continued on page* 21)

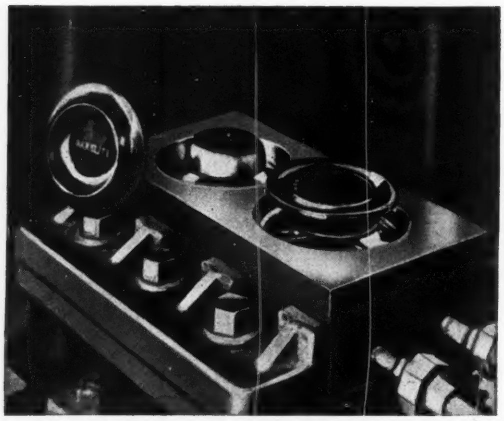
● THE MOLDING PROCESS



Loading preforms in mold



Position of press during molding operation

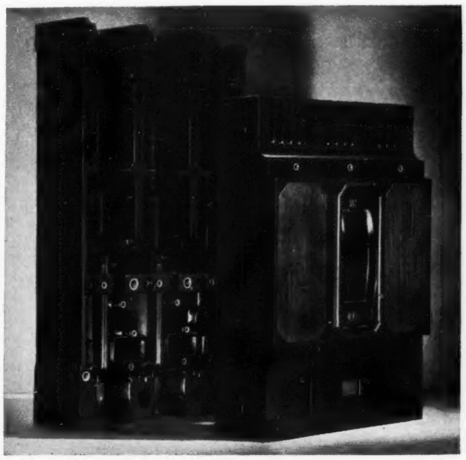


Removing molded parts

The finished piece

● **THE MOLDED PRODUCTS**

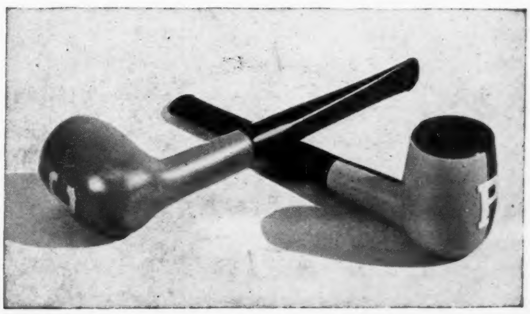
Toledo Scale



Electrical Apparatus

Typewriter Case

Thrust Bearing



Pipes

—Courtesy of Bakelite Corp.

The Cornell Engineer

Editorial

There has been much comment on the recent announcement of the Administrative Engineering Department to the effect that any student whose absences, excused or unexcused, exceed by one the credit hours of a course, will be required to take and pass the final examination. In the student's mind, this announcement has counteracted to a great extent the accompanying announcement that in many courses points would no longer be deducted for cuts, a change of rules which Engineers have desired for three years.

As in any controversial question, the arguments of both sides must be considered. In this case, the faculty believes that any student who has missed three or four classes should not be exempted, regardless of his average, because there is not sufficient evidence that he has studied and understands the work he has missed. Feeling that this proof will be obtained in the final examination, and that studying for the final will force the student to make up anything he missed, the faculty believes that it has invoked this rule in the students' best interest.

The student, on the other hand, has several lines of reasoning to oppose this view. In the first place, any work missed by a student who is absent will be covered by a prelim, from which there is no excuse. Furthermore, any student who can maintain an exempting average without attending every class must have a greater knowledge and understanding of the course than the student who maintains the same average while attending every class and getting all possible help from his instructor.

The new rule also places a penalty on students who engage in outside activities, and tends to further discourage the hard-working engineer who tries to make a name for himself on the hill in spite of the heavy load of studies he carries. In many cases, participation in a sport or other activity will necessitate enough excused absences from class to require the athlete or manager to take a final examination. This becomes doubly annoying to the handful of students who are accustomed to exempting all of their courses, and who will have to remain in Ithaca to take one final in some course, possibly one of their easier ones, in which they have maintained an exempting average. It also prevents students who are having trouble with one course from putting all of their time during finals week on that course.

The student argues further that the ruling tends to discourage Seniors from making out-of-town trips in search of jobs, and penalizes the man who, in spite of a period of sickness, has raised his average about the point ordinarily required for exemption.

Not wanting to be accused of offering nothing but destructive criticism, we would like to suggest that the rule be modified to cover unexcused absences only. As far as we know, there is no other department which provides any penalty for an excused absence, and it is this new policy which is causing resentment. The rules of the College of Engineering provide for leaves of absence only in cases where it is to the best interest of the student or the University to grant them, and it does not seem reasonable that students should be penalized for using these leaves.

Try as we may, we cannot help being prejudiced for the student, and we may easily have presented too weak a case for the faculty. We were very glad to see the elimination in many departments of the old (C/N)60 system, and we feel that the faculty of the Administrative Engineering Department will give every consideration to the students' opinions on the new ruling.

News of the College

November comes but once a year and with it comes the closing weeks of the football season, and the grand finale in the Penn Game. We were wondering the other day how many engineers managed to mix football signals with calculus. And we found out, contrary to the public opinion that all football players are in the Hotel School that there are some twelve slide rule pushers on Mr. Snavely's roster. Outstanding is Al Kelley '41, that cagey end with the deadly tackle, while Dick Stimson '41 has frequently taken Matuszczak's place as blocking back. Bill Worcester and Freddy Jaicks are the senior members of the squad. Norm Christensen, Fred Grimshaw, Don Goodkind, John Lewis, Ed Mead, Harry Tredennick, Ed Van Order, and Pete Wolff, all sophomores, are still proving their worth. With this group of second year gridders, there should be plenty of fancy engineering on the team next year.

The football managerial positions are even more strongly represented, as both Manager Dean Wallace and assistant manager White pursue their studies within the sequestered walls of Sibley and Lincoln. Perhaps the engineer's super-efficiency has something to do with his success in this line.

The fall has brought war in Europe, and we find that the faculty have had several personal contacts with it. Most have heard by now of Professor Boynton's experience on the Athenia, but few know of Mr. Myklestad's, instructor in the mechanics department. This summer Mr. Myklestad took a trip home to see his family in Oslo, Norway, and was there when hostilities began. His passage on the German liner, Europa, was cancelled, and he returned on the Stavangerfjord. While in Germany three days before the outbreak, he noticed that the German people didn't appear to know what was going on; and certainly did not hear anything about England.

Perhaps you are wondering what sort of antiquated pictures we are using in the magazine, as you notice the old drawing on this page. It was uncovered while looking up material for the Thurston Centennial, and shows the first dynamo built in the Western Hemisphere. The generator was constructed here at Cornell years before the E.E. school was started, and is shown to all freshmen physics classes, as many of you will recall.

The front cover also has an interesting background. It is a photograph of the excellent scale model of the proposed engineering buildings which is in the foyer of the administration offices in Sibley. To those of you who haven't looked at it closely, we say that the model gives an excellent idea of what the new buildings will look like in their setting on the campus. The fact that the layout is at eyelevel aids in the realism.

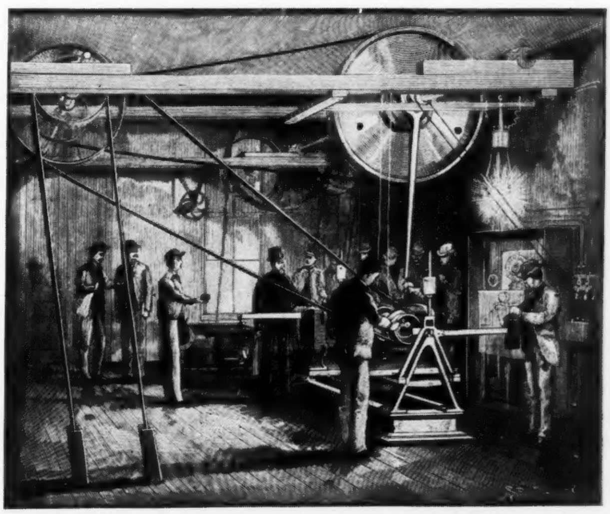
The fact remains, however, that we still have the old buildings, and the administration of the college is continuously making improvements in the existing conditions. Most progressive has been the consolidation of the mechanical and electrical libraries. The Electrical Engineering volumes have been transferred to Sibley Dome and recatalogued with the Mechanical Engineering books according to the system used in the Library of Congress.

The best news from the library is the notice of the new hours. The doors will be open from 8 A. M. to 5 P. M. and 7 P. M. to 10 P. M. on Monday through Friday, and from 8 A. M. to 1 P. M. on Saturday. Now that the Engineering library is open in the evenings like the main library, more use should be made of the fine collection available.

The "Engineering Browsing Library", a collection of 100 volumes recommended by the English and Public Speaking department will be again available to all engineers. This collection of selected volumes strikes us as a good idea, inasmuch as most engineers have never been in the University library, much less taken a book out.

The Civil Engineers haven't been slighted in this business of improving facilities. A new Hydraulic Lab has been opened, and equipment for study of flow in open channels has been installed. A big item was the installation of a new 400,000 pounds materials testing machine to be used in testing concrete blocks. Of greater interest to the students was the improvement of lighting facilities in the drafting rooms. Five of the six rooms have new fixtures featuring indirect

(*Continued on page* 28)



The First Dynamo in the Western Hemisphere

NEWS OF ENGINEERING ALUMNI

The attention of the Alumni is directed to the present campus organization concerned with the employment problems of Cornell graduates in Engineering.

The College of Engineering maintains a Personnel and Employment Office to operate the personnel system of the College, and to supervise the placement of seniors and alumni. In addition the University maintains a general Placement Bureau with which the College placement office cooperates very closely. In the alumni placement field, the College office conducts a Five-Year Service Plan which consists of mailing circulars to the class at the beginning of each year for five years after graduation, and then at five year intervals to learn of their work, success, and desires as to change in position. This plan has been in operation since 1928.

Employment opportunities for alumni frequently come to the attention of the College or University and this information is exchanged. Immediate recommendations are made on the basis of the five-year-plan returns or from an employment file of more experienced alumni who have expressed a desire to change positions. Additional graduates are recommended on the basis of applications from those who are interested after receiving notice of openings from the JOB BULLETIN of the University Placement Bureau. This bulletin is received by those who have expressed a desire for employment information to either the College or the University Placement Bureau, and contains the majority of current openings which have come to the attention of the College or University office.

Hence, Engineering graduates who may desire a change in employment or job information are urged to write to either the Personnel and Employment Office, Sibley Dome, or to Mr. H. H. Williams, C.E. '26, University Placement Bureau, Willard Straight Hall. Cornellians in the vicinity of New York City may obtain information about job specifications at the office of Paul O. Reyneau, M.E. '13, who directs the placement service of the Cornell Club of New York, 107 East Forty-eighth Street, New York City.

After twenty-eight years of active service on the Boiler Code Committee of The American Society of Mechanical Engineers, William H. Boehm, engineer, educator, and executive, retired on April 28, 1939, at which time his colleagues on the Committee honored him with a dinner at the Engineers' Club, New York. Dr. D. S. Jacobus, chairman of the Committee, presided.

The occasion took the form of a mock imitation of the regular proceedings of the Boiler Code Committee, at this "special session" of which reports of special committees were read by Henry B. Oatley, Charles E. Gorton, and Dean Arthur M. Greene, Jr. According to these reports, Mr. Boehm was the last remaining active member of the first seven members of the Committee appointed on Septmber 15, 1911, by Col. E. E. Meier, during his term as President of the Society.

Since 1911 the Code has been changed from an incomplete document into one which has served the public and the profession so well in promoting safety, continuity of service, and unrestricted sale of pressure vessels, that it has been incorporated into the laws of 24 states, 18 cities, the Panama Canal, and the Hawaiian Islands.

In his capacity as executive of one of the leading insurance companies in the country, Mr. Boehm originated "flywheel insurance," out of which grew engine and turbogenerator insurance. This was followed by his development of power-machinery insurance which has been adopted by all casualty insurance companies.

Mr. Boehm was born in Memphis, Tennessee, August 30, 1868. He received pre-college training as an architectural and mechanical draftsman, and entered Rose Polytechnic Institute in 1887, from which he was graduated as Bachelor of Science in Mechanical and Electrical Engineering in 1891. In 1891 he came to Cornell, where, in the two years following, earned his Master's Degree in Mechanical Engineering.

After graduation, Mr. Boehm was engaged as an instructor in Mechanical Engineering at Washington University, and later as Professor and Dean of Engineering at Clemson College. He has had a wide range of experience, from mechanical drawing to design and invention. He has made investigations and testified as an expert witness with regard to boiler and dust explosions. He is the author of *Steam Boiler Explosions, Power Machinery Accidents,* numerous engineering articles and reports, and is a contributor to the current edition of Kent's *Mechanical Engineers' Handbook.*

CORNELL SOCIETY *of* ENGINEERS

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PAUL A. REYNEAU '13, Secretary-Treasurer
107 East 48th Street, New York, N. Y.

HERBERT H. REYNOLDS '11, Recording Secretary
New York, N. Y.

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

President's Column

Fellow Engineers:

Our President, Willis Carrier, is still away on an extended trip at the time that this column has to go to press and once more I will endeavor to "pinch-hit" for him.

During this month, the one hundredth anniversary of a great teacher was held at the Engineering College at Ithaca. In addition to being a fitting tribute to a man who contributed greatly to the rich background of Cornell, this occasion seems to me to be a symbol of something most important to all Cornell Engineers.

Among the great universities of the east, from the point of view of the date of its founding, Cornell is "new." This may be said of Cornell as a whole, but in the engineering schools we have a tradition far greater than that of any other university in the country. Ezra Cornell and Andrew D. White, pioneers of a new form of education, established a school to instruct in a profession which today might even be considered the bulwark of what has made industrial success in the country. Certainly without engineers and the kind of training they are given in this country we could not have expanded our industrial system with such rapidity or such success. The schools of engineering at Cornell have been headed since their founding by faculty and deans whose names read like an index to "Who's Who."

Dr. Thurston was one of these. These men pioneered not only in their own arts but in the teaching of those arts to young men who went forth into the world to build a great industrial era which has provided for this country the highest standard of living ever before achieved in the world.

Today, more than ever, we in America appreciate not only the fine foresight of our leaders who drafted the Constitution which keeps us free, but we are thankful for the skill and ingenuity of the research man, the farsighted engineer and industrial leader, and the background of technical education which has made it possible for us to enjoy more freedom and more of the comforts of life than any other people in any other land.

This position of America, as those of us here well know, is not an accident. It is not the result of a master mind, nor even a group of master minds, among us who organized us like an army to produce more goods; but it is the result of freedom of thought and the opening of opportunities for the advancement of learning among all of our people.

There are other engineering schools. There are other *great* engineering schools, but it can be truly said that none have sent out into the world so great a number of yesterday's and today's leaders in the technical field as Cornell.

It seems to me fitting that we should develop our own Cornell engineers "Who's Who." We all know the names which rightfully head the list. The people of real ability who have contributed much are often the most modest, however, and we must depend upon their friends to hear of them.

As a part of the regular activities of the Cornell Society of Engineers, I would like to make the suggestion that we assemble a list of the great names connected with Cornell engineering faculty and alumni. Following out the objectives of our Society, it is my hope that we may develop such a list into such form that we may use it to spread to those newer students of today and tomorrow of Cornell engineering a real knowledge of the men who have gone before them and the kind of a mark that has been set for them to attain. This would be more than a list. It would be a roll of honor.

If others agree with me that this is worthwhile and could prove to be a source of inspiration to our younger generations, I hope that nominations for positions on this roll may be sent to the Cornell Society of Engineers headquarters office in New York.

Yes, Cornell engineering is rich in tradition, but we who know it must not let it be forgotten in a world which is too prone to look entirely to the future and forget the foundations of the past.

Yours very truly,

JOHN P. SYME,
Executive Vice-President.

MODERN PLASTICS

(*Continued from page* 13)

liquid material under pressure. If the pressure on the materials, transmitted by the piston, is 8 tons per square inch, and if the maximum cross-sectional area of the mold cavity parallel to the parting line of the mold, or at right angles to the general direction of flow, is 10 square inches, then the force tending to open the mold is 8 times 10, or 80 tons, assuming that the plastic material behaves as a true liquid. Since the latter is probably not true, the force developed is probably somewhat less than that calculated. The average time required for a molding cycle varies from 15 to 45 seconds.

Compression Molding

Molds for compression molding are best made of low-carbon machine steel, pack-hardened, polished, and preferably chromium plated. Tool steel, hardened, polished, and plated, may be used if the mold is to be heated by conduction. The use of alloy steels is not desirable in molds in which the heating and cooling media come in direct contact with the metal of the mold cavity for the alternate heating and cooling tend to crack the metal.

Coring of the molds for heating and cooling should be as generous as possible, as long as the strength of its parts is not endangered thereby. Rapidity in heating and cooling makes for economy in molding.

To prevent clogging of the cores of the mold with water, the outlet for water and steam should be at the lowest level of the coring. The return steam line should be designed to avoid the collecting of condensate and should be effectively trapped.

The best combination of temperatures and hydraulic pressure for a given article may be worked out by actual trial, but, within reasonable limits, a deficiency of the one may be compensated by an excess of the other. Molding pressures will vary, depending upon the shape of the article and the type of powder used, from about 1500 to 3000 pounds per square inch. Saturated steam at 150 pounds per square inch pressure furnishes a high enough temperature for practically any compression molding and in many cases less than this will prove sufficient.

Channels cut through the metal of the molds or jackets around the molds permit them to be heated rapidly by circulation of live steam under pressure and then be cooled rapidly by circulation of cold water. A suitable quantity of the molding compound is placed in the lower half of the mold; the mold is then heated to soften the compound to a flowable condition and the mold is closed by application of hydraulic pressure. The molding compound is consequently forced to flow and fill the mold cavity. After this operation the steam is turned off and cold water is introduced into the jackets of the molds. The molded article is thereby cooled while being maintained under pressure. Thereafter, pressure is released to reopen the molds, from which the article is removed.

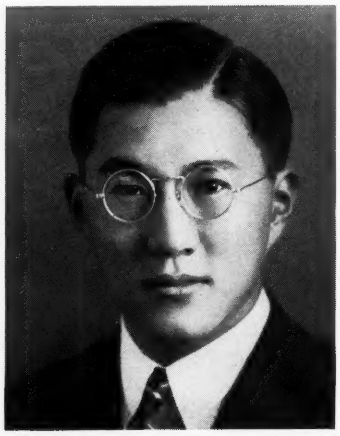
The practice of preforming or compressing the charge into a tablet before the molding process is begun is now recognized as an advantageous step and is widely employed. In this operation the molding powder is cold-pressed into a compact mass of proper form and weight. In form, the tablet should roughly follow the contour of the mold. While preforming involves an extra operation, it is cleaner and more convenient than weighing the charge, eliminates waste and speeds up and simplifies the molding operation. This increases the output per mold as well as guaranteeing a more homogeneous molded product.

The cycle of the molding operation depends upon the size and shape of the article and particularly upon the thickness of section of the articles, being shortest for thin-walled small articles and longest for heavy-walled large articles. It depends likewise upon the rapidity with which the mold can be alternately heated and cooled; care and skill in the design of molds from this standpoint is well rewarded in the increase in speed of operation. In general, the molding cycle for compression molding will range from about one and one-half minutes or less for a small article in a well-designed mold up to four or five minutes or more for a large article. Two and a half to three minutes is perhaps a fair average. The cycle may frequently be shortened by pre-heating the molding compound before putting it into the mold.

The success of the engineer in the past and the present is but an intimation of his importance in the world of tomorrow. New industries flourish while others die, as his creative genius and new discoveries steadily improve the quality of our manufactured products and make their benefits available to a larger percentage of the American people. We shall be the engineers of the future and upon us depends the progress of our generation. The plastics industry, like so many others, is comparatively young; its new revelations will continue to revolutionize the industrial world.

The writer wishes to thank the Bakelite Corporation and E. I. du Pont de Nemours & Company, Incorporated, for the information given relative to this topic.

SENIOR PERSONALITIES



FREDERICK G. JAICKS A.E. '40

Steel is big. But that fact about his chosen field should be no deterrent for Fred Jaicks who has spent his career at Cornell both literally and figuratively tackling big things. A McMullen Regional Scholar, he has maintained a scholastic average of 83% and has been a member of the varsity football squad for three years.

Fred hails from Hinsdale, Illinois which is near the heart of the mid-west steel producing section. Following the lead of three uncles, who are Cornell engineers, he plans to enter the steel buisness. His interest and experience in the subject has been greatly incrased by a summer job as a common laborer, known colloquially as a "cinder snapper", officially as a third helper, in the open hearth furnaces of the Wisconsin Steel Company. Interested primarily in production, here he received an insight on steel manufacture from the ground floor.

This past summer he worked in the newly developed Illinois oil fields as a member of a drilling crew. As a non-experienced handy man, he was known as a "boll-weevil" (derivation unknown). In addition to gaining valuable engineering experience, he found the strenuous life of working on a drilling rig kept him in physical form for the coming football season.

In addition to playing varsity football, Fred was a member of Cornell's rugby team and has enthusiastically followed the development of that game in American collegiate circles. He has combined his excellent scholastic standing with many extra-curricular activities. He is a member of the Student Council and Sphinx Head. Honorary societies include Tau Beta Pi and Kappa Tau Chi. And to round out his interests and activities, he has the worry and responsibility of his fraternity, Chi, Psi, as House President.

TEH-CHANG KOO M.E. '40

The opportunity to come to Cornell was all that Teh-Chang wanted, to prove that he had the makings of an engineer. A member of the Cornell Branch of the Telluride Association, honorary scholastic institution, he is one of the four in his family now attending universities in the United States. Teh-Chang's father is the Chinese Ambassador to France and China's chief delegate to the League of Nations. His father is a graduate of an American University and it was partly due to his influence that Teh-Chang decided on Cornell. Before he came to Cornell he completed seven years of preparatory work in Northen China including a year at the University of Soochow.

Aviation has always fascinated him, particularly that branch connected with the construction of airplanes. In China, today, the quickest means of travel is the airplane and in view of this, he is planning to return to China and enter work connected with civil aviation.

Teh-Chang has been in numerous activities on the hill, all of which, he feels, have been of considerable value to him. Among his many activities are: President of the Cornell in China Club, President of the Cosmopolitan Club and Vice-President of the Cornell Branch of the A.S.M.E. He is also a member of the Chinese Engineer's Club, an organization devoted to keeping its members posted on engineering advancements in China, Quill and Dagger, Atmos, and Tau Beta Pi.

Teh-Chang feels that he will receive a great deal more from Cornell than merely his degree. He has participated in extra-curricular activities and is convinced that Cornell is far ahead of most schools in the variety and number of activities offered to the student. It is up to the student, however, to make the most of these

DANIEL H. SEIPT EE, '40

It is with regret that we learned of the untimely death of Daniel Henry Seipt '40 EE in an automobile accident at Meadow and Buffalo Streets in Ithaca, September 30. Daniel Seipt came from Langhorne, Pennsylvania and attended the George School near Philadelphia before coming to Cornell.

Those of us on the Board of the CORNELL ENGINEER who had the privilege of being his friends and associates feel that his absence only makes us certain that he was one of the finest and truest fellows we have known. He was a man about whom only the best can be said. Since he was forever cheerful, and always willing to lend his help wherever needed, he made many friends both on the hill and in his fraternity, Phi Sigma Kappa. He was house manager and treasurer of his fraternity. Gifted with an active mind, he had several hobbies and received excellent grades. His three principle hobbies were tennis, radio, and swing music. Many of his afternoons were spent playing tennis, while his interest in radio frequently engrossed him at night. He was also an authority on swing music, being able to recognize any popular band or instrument. Electrical Engineering is one of the most difficult courses at Cornell, and yet he maintained a high average.

Daniel Seipt would have made a name for himself in life. It is not necessarily the BMOH's who are, or will be, successes. There are other requirements. Daniel Seipt was not a BMOH, but he was a success because he had those requirements namely, intelligence, co-operativeness, diligence, and friendliness. It is men like Daniel Seipt who make this world a better place.

opportunities. With four years of Cornell behind him Teh-Chang is going to return to China and help the Cornell graduates now there promote engineering development.

Prominent Professors

PROFESSOR B. K. NORTHROP

Odd and interesting was Prof. Northrop's school life. After preparing at a private school in Florida, he attended Stetson University for two years. He then transferred to Cornell as a sophomore. In his junior year he taught freshman physics and throughout his senior year was an instructor in materials. Graduation in December 1918 produced no abrupt change in his life for he remained with the engineering staff and continued with his teaching.

Since Prof. Northrop was a student here during the last War, it is interesting to record his impressions of Cornell as he saw it then. He vividly recalls the shrinking classes as more and more students, his friends, left to serve abroad. Prior to the War military training was required one hour three days a week following afternoon labs; our present system of one afternoon per week was effected during the War. Prof. Northrop sympathizes with the sophomore basics for he remembers that bayonet practice and other revisions in drill regulations confused and annoyed them too.

Long will he remember the roar of airplane engines under test and the occasional staccato of machine guns heard night and day as the Thomas Morse Aircraft Corporation designed more powerful engines and conducted experiments to develop synchronous machine gun fire.

Let us now take a peek at the prof in his less formal moments. Indicative of the congenial relationship existing between prof and student is the following incident. One day last year Prof. Northrop appeared in class smoking a cigar as is his custom. During the recitation he placed his cigar on the desk and forgot about it. Next morning all his students who were capable of so doing entered class smoking cigars. On the day of the final exam a cigar about a foot long and an inch in diameter appeared mysteriously on his desk. Prof. Northrop accepted the challenge; while the boys struggled with their problems, he puffed contentedly on the cigar.

Prof. Northrop's interest in teaching is sincere; his hobby is his work; the pleasure he derives from helping students is responsible for his popularity among them.

PROFESSOR F. G. SWITZER

There are not many who are aware that Cornell's radio station, WESG, once had its studios in Sibley College and that Prof. F. G. Switzer, head of the Dept. of Mechanics of Engineering, was its studio manager. That was back in the infancy of radio when the station broadcast for only two or three hours each day. WESG has grown and now has its own studios. And Professor Switzer has retired from the active phase of radio. However, he still maintains an interest in the field and for a hobby and recreation builds radio receivers, getting especial enjoyment out of constructing parts that cannot be bought commercially.

A native New Yorker, Frederick George Switzer prepared at Trinity School, and entered Cornell in 1909. At that time intercollege athletics were much more prominent than today, and "Switz", as he was known as an undergraduate, served for two years as coxswain of the Sibley crew. He was also treasurer of the Sibley Athletic Association during his senior year.

Graduating as an M.E. in 1913, he stayed to earn his M.M.E. degree in 1914 holding the Sibley Fellowship. This was before electrical engineering was recognized as a distinct branch and prospective electrical engineers then took a fourth year option in electricity but graduated as mechanical engineers.

Some have attributed the arousing of his intense interest in hydraulics to his undergraduate days when as coxy of the Sibley crew, he bucked the icy waters of Cayuga; but he himself gives the credit to his hydraulics instructor, R. L. Daugherty. After designing electrical machinery for two years, young Mr. Switzer returned to Cornell in 1916 and succeeded Daugherty as instructor of hydraulics. He was appointed assistant professor in 1917 and full professor in 1924, a record advancement.

Nationally known as an authority on hydraulics, he has done important consulting work on many projects, namely power plants and centrifugal pumps. As vice-chairman of the Hydraulics Division of the A.S.M.E., he has presided over meetings at national conventions. Professor Switzer is a member of Sigma

Management Looks to The Future

(*Continued from page* 10)

Then he described how modern medicine trains the physician:

> The student walks the hospital wards with skilled physicians; he is made to watch skilled men in the act of observation, in the act of judging the particular instance; he is himself made to take responsibility for fellow human beings—under guidance; he is made to accept this responsibility and to develop *balanced judgment* in the process of utilizing many scientific techniques.

This is the clinical approach. It utilizes all the advances of science; it coordinates them with the judgment and experience of the able clinicians.

Business and industry have not, as a general rule, undertaken seriously to train the administrators of tomorrow. There are, it is true, training courses in industry, and there is certainly no lack of able "business clinicians." But have these leaders recognized their responsibilities? Has management specifically stated their duties as clinicians, or systematically coordinated training programs with business schools and colleges of engineering? Until an affirmative answer can be given to all of these questions management is not fully preparing for tomorrow.

Educational Implications

As an educator, I cannot close without at least a suggestion of what these trends hold for education—especially engineering education, which aims to train not only the technical specialist, but also the administrator. By implication, at least, these trends of management in the world of tomorrow indicate to all engineering educators the thought expressed by Dean Willets of the University of Pennsylvania at the Seventh International Congress when he said: "*Make your training broad and social as well as technical and practical.*"

Xi and Phi Kappa Phi. Because of his work in hydraulics, he is an associate member of the American Society of Civil Engineers.

Alert to the rapid changes and developments in engineering, Prof. Switzer pioneered at Cornell in the field of photo-elasticity and its application to machine design. Realizing the importance of this expanding field, he was instrumental in inaugurating a photo-elasticity laboratory at Cornell.

A true Cornellian, Prof. Switzer has left his mark upon the hill, and therefore it is fitting to quote from the 1913 Cornellian: "Cornell has made a man of Switz. There has been many a laugh at his expense—and many a confidence poured into his ear. And of him we say: 'We're glad that you came'."

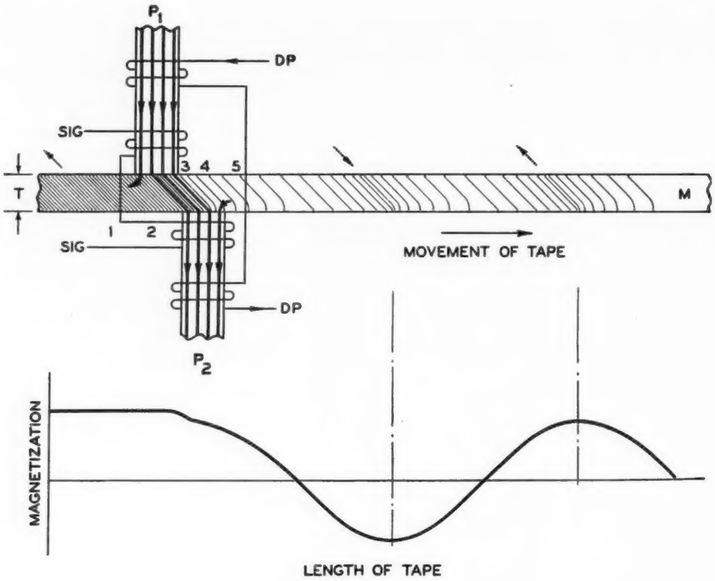


Fig. 3

MAGNETIC SOUND RECORDING

(*Continued from page* 7)

3 mm. wide, and is produced in lengths of 1000 meters. Several of these are joined together with silver solder to make a tape long enough to play continuously for half an hour or more, traveling at a speed of 1.5 meters per second.

Another machine, also using longitudinal magnetization, has been developed in this country. This apparatus, using single-pole-piece recording, was constructed by a private experimenter, T. J. Malloy of Joplin, Mo. Malloy has preferred to use wire as a recording material, since it permits more length to be stored on each reel.

The construction of the head of this machine is considerably different from the British unit. It consists of a cylindrical shell encasing an electromagnet, whose laminated core extends outward to form jaws in which is held a removable pole tip. The pole tip projects from a rectangular opening in the casing so that it may make contact with the wire as it passes. The wire is kept in its proper position with respect to the pole-piece by a curved plate containing a v-groove in which the wire is constrained by the tension caused by the driving motor. The wire used in the machine is 0.001 inch in diameter and travels 5 feet per second. The pole-piece is 1/16 of an inch wide; 1/64 of an inch thick, and sharpened at the end to a thickness of 0.001 inch.

The use of the shield around the magnetic coils has several results. First of all, it provides a return path for the flux surrounding the coil so that the only flux acting on the wire comes from the pole-pieces. When the coil is switched over so that it operates as a reproducing head, the shield prevents the magnetization of the wire from acting on the coil except when in direct contact with the pole-piece.

Through careful design and simple construction Malloy has made his outfit portable, so that it may be carried around for demonstration. He uses the machine to record radio programs and also entertains local civic organizations with demonstrations.

The applications of magnetic sound recording are many and varied and will become increasingly numerous as the technique of producing the record improves. At the present an essentially uniform response up to 8000 cycles may be obtained by the magnetic system, performance equal to that obtained from other systems.

One of the most important uses of the steel tape recorder, especially in England, is the re-broadcasting of radio programs. There, programs presented for London audiences, are recorded and re-broadcast on short wave at the proper times to reach listeners all over the British Empire. Since the program must be repeated several times to reach all listeners at the proper times, the record must be capable of being replayed frequently without loss of quality. And magnetic records deteriorate less rapidly than the conventional disks. The long uninterrupted record of steel tape makes this system especially well adapted for re-broadcasting long programs.

Reliability is an important factor in the choice of a recording system. The British experience with the magnetic type has been entirely satisfactory. During the year 1936 magnetically recorded programs were on the air a total of 1957 hours, with only 39 minutes

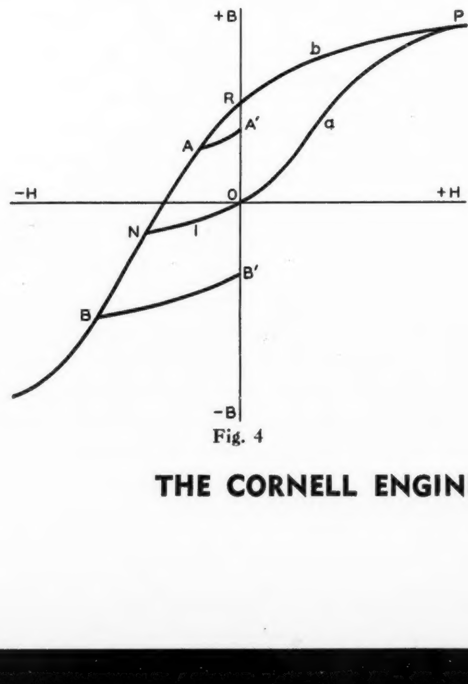


Fig. 4

of breakdown time, most of which was due to tape breaks.

In broadcasting live programs on the radio, peculiar echo and reverberation effects are often required. Usually expensive echo chambers are constructed. However, a magnetic recorder can be used to produce the same sound effects. If a reproducing head is placed immediately behind a recording head, the sound is reproduced a fraction of a second after it is recorded. By increasing the number of reproducing heads, and by proper spacing, all types of echoes and reverberations may be produced.

In broadcasting weather reports and other signals which must be repeated, magnetic recording is an ideal system. The steel tape is made in an endless loop, thus reproducing the message over and over.

Another application of the endless loop type of reproducer comes in animated advertising displays, where it is desired to describe repeatedly some feature of the exhibit. A magnetic reproducer operating through an amplifier and loud speaker in front of the display provides a very effective method of calling attention to some particular feature of the spread.

Business firms find an additional use of steel tape recorders as dictaphones. This particular utilization is quite popular, especially in Germany. The re-use of the record material makes this type of dictaphone very economical.

A small portable recorder and reproducer has an interesting application in the study of voice and language. The unit which is contained in a cabinet similar to a radio, records for fifteen minutes on an endless tape, and then automatically begins reproducing what has been recorded. Thus objective study of the progress of the student can be made.

In considering the various processes and applications of steel tape recording, it can be seen that there are many uses for the system where other systems would be impractical. It should be realized, of course, that magnetic recording has its disadvantages, and is by no means a substitute for either of the other two methods. However, continued development of the system will bring many uses to the field not even dreamed of now.

COLLEGE NEWS

(*Continued from page* 17)

lighting.

Now that the freshmen have had their first prelims and are beginning to find what it takes to stay in Cornell, we suggest that they and the rest of the undergraduates remember Dean Hollister's advice to the yearling class as he presented it in Introductory Lectures. The Dean pointed out that the number of offers of employment a graduate receives is directly proportional to his standing in the class. Top quarter students are offered many more jobs than those ranked in the lower quarters.

But good grades do not have to wait till graduation to find their reward. Tau Beta Pi, engineering honorary society, recognizes the outstanding students in the junior and senior classes. We would like to point out to the frosh that a Tau Bete key is valued by some even more than the well known and time honored Phi Beta Kappa, which exists in the Arts College. We happen to mention this because of the trip Joe Coors, Tau Bete president, took to Columbia, Mo., on October 15 to attend the national convention of the society. The Key men have had their first meeting to lay plans for cooperation in the Thurston Centennial. Joe Coors, Crawford Adams, Paul Swatek, Dean Wallace, and Beach Barrett form the committee to aid in this project.

STRESS AND STRAIN

Judge: What do you do for a living?
Victim: I'm night orderly in the hospital.
Judge: Thirty days for panhandling.

—*Pennsylvania Triangle*

* * *

The professor who comes in late is rare; in fact he's in a class by himself.

—*California Engineer*

* * *

"What's the hurry?"

"I just bought a text book and I'm trying to get to class before the next edition."

—*The Kansas Engineer*

In spite of all the comment we still contend the ventilating engineer makes the best draftsman.

—*The Kansas Enginer*

* * *

"Yes sir, as sure as I sit here now I shot that old double-barrel in that flock of ducks and I brought down five of them."

"Didn't I ever tell you about my hunting frogs the other night? Fired once and 500 of them croaked."

—*Nebraska Blue Print*

* * *

Then there was the electrical engineer who jumped up from his chair because he had amps in his pants.

—*The Kansas Engineer*

G-E Campus News

20,000,000TH OFFSPRING

LAST month, the historic city of Lynn, Massachusetts, paraded, unveiled a tablet, and had a ceremony in its new stadium—all because of the 50th anniversary of one of its most prominent families. But commendable as a Golden Anniversary may be, that was only part of the reason. The city was also hailing the arrival of the family's 20,000,000th offspring.

"Watthour meters" is the family name, and it was in 1889 that Professor Elihu Thomson, electrical genius, developed the first practicable meter of this type. Produced by the Thomson-Houston Electric Company, one of the organizations which were merged in 1892 to form the General Electric Company, this early meter stepped into a world having only 17,500 household users of electricity. The 20,000,000th meter joined a world which in 1938 had 22,900,000 household users.

The G-E factories at Lynn today are a far cry from the small factory of 50 years ago which produced little dynamos and arc lamps—two great factories now produce powerful motors, ship-propulsion equipment, turbines, superchargers for airplanes. At Lynn, too, there is a division of General Electric's Test Course for recent graduates of engineering colleges.

SNOW CRUISER

WHEN it comes to dignity, Antarctica's penguins, with their permanent tail coats and stiff shirts, are right in the front row. But their dignity is due for a shock. A "snow cruiser" will soon be rolling across the penguins' icy front yard. Putting it mildly, this cruiser is quite different from the locomotives, trolley coaches, and other vehicles that G-E engineers help to build or equip. But these engineers weren't the least perturbed when called upon to design electric equipment for the strange conveyance. Four G-E traction motors, generators for the two 150-hp diesel engines, and complete control equipment were installed.

The cruiser was designed by the staff of the Research Foundation of the Armour Institute of Technology for use by the Government during the U. S. Antarctic Service under Rear Admiral Byrd. It is so built that it will crawl over crevasses 15 feet wide. Constructed by the Pullman-Standard Car Mfg. Co., the vehicle is 55 feet long and will weigh 75,000 pounds when fully loaded. Ten-foot pneumatic tires support the four wheels. A five-passenger airplane is carried on top.

OPPORTUNITY

IN five universities, eight selected college graduates are doing research work in electricity, physics, and chemistry, aided by Charles A. Coffin Foundation Fellowships. As undergraduates these men attended the U. of Cincinnati, Johns Hopkins, College of the City of New York, U. of Washington, Oberlin, Columbia, Muhlenberg, and Denison.

These awards are granted annually by General Electric in honor of the Company's founder and first president—Charles A. Coffin. Several previous recipients have attained national, and even international, fame; one, Dr. Carl D. Anderson, has received the Nobel Award in Physics—probably the outstanding recognition for scientific achievement.

The committee of three distinguished men who will make next year's awards is composed of: J. H. VanVleck, representing the National Academy of Sciences; Olin J. Ferguson, representing the Society for the Promotion of Engineering Education; and F. Malcolm Farmer, representing the American Institute of Electrical Engineers. Applications for the 1940 fellowships are now being distributed to colleges and universities. They must be completed and returned to the Secretary of the Charles A. Coffin Foundation, Schenectady, N. Y., before January 15, 1940.

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